

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization  
International Bureau(43) International Publication Date  
27 September 2001 (27.09.2001)

PCT

(10) International Publication Number  
WO 01/71836 A1(51) International Patent Classification<sup>7</sup>: H01M 8/02

(21) International Application Number: PCT/NL01/00234

(22) International Filing Date: 22 March 2001 (22.03.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
1014722 22 March 2000 (22.03.2000) NL(71) Applicant (for all designated States except US): STICHT-  
ING ENERGIEONDERZOEK CENTRUM NEDER-  
LAND [NL/NL]; Westerduinweg 3, NL-1755 LE Petten  
(NL).

(72) Inventor; and

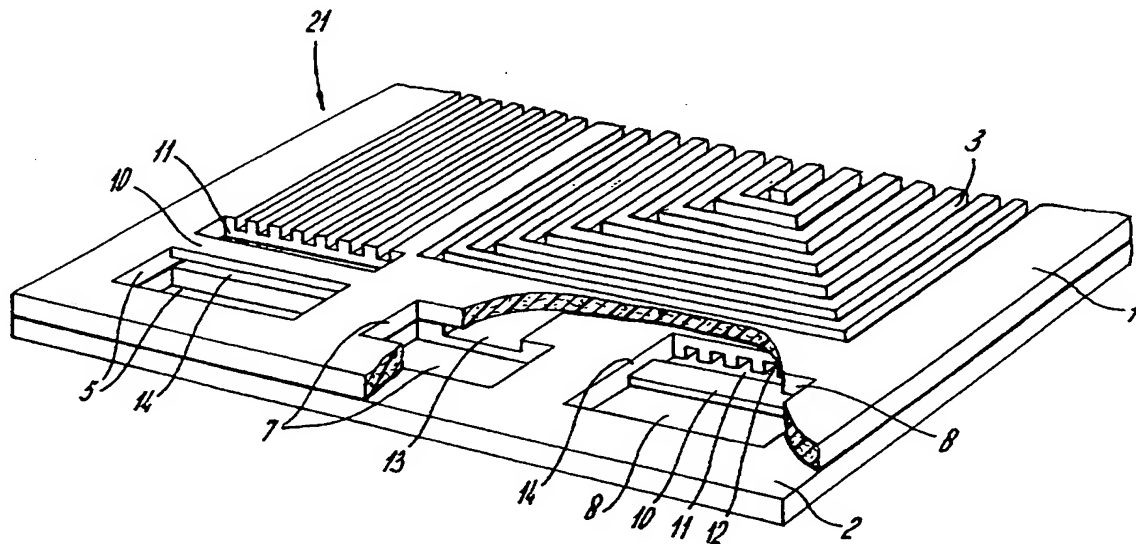
(75) Inventor/Applicant (for US only): MALLANT, Ronald,  
Karel, Antoine, Marie [NL/NL]; Koggewaard 83,  
NL-1824 GP Alkmaar (NL).(74) Agent: JORRITSMA, Ruurd; Nederlandsch Octrooi-  
bureau, Scheveningseweg 82, P.O. Box 29720, NL-2502 LS  
The Hague (NL).(81) Designated States (national): AE, AG, AL, AM, AT, AU,  
AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU,  
CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM,  
HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK,  
LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX,  
MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL,  
TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.(84) Designated States (regional): ARIPO patent (GH, GM,  
KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian  
patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European  
patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE,  
IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF,  
CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:

— with international search report

For two-letter codes and other abbreviations, refer to the "Guid-  
ance Notes on Codes and Abbreviations" appearing at the begin-  
ning of each regular issue of the PCT Gazette.

(54) Title: PLATE, PLATE ASSEMBLY AND ELECTROCHEMICAL CELL STACK



(57) Abstract: Plate, more particularly a separator plate, provided with fluid channels which are designed as grooves. These fluid channels open out into continuous inlet or outlet openings. In the vicinity of the location where they open into the inlet or outlet, there is a cover for the groove or grooves, in order to provide a sealing surface with an adjoining part of a fuel cell stack. According to the invention, this cover consists of the same material as the plate in question. On the "undesirable", this cover is designed as a recess. If appropriate, a further opening may be present between the recess and the end of the grooves.

WO 01/71836 A1

Plate, plate assembly and electrochemical cell stack

The present invention relates to a plate provided with a fluid channel designed as a groove, said plate being suitable for forming part of an electrochemical cell stack, said plate being provided with an inlet and/or outlet adjoining said fluid channel, said inlet/outlet comprising a continuous opening which extends perpendicular to the surface of the said plate, said channel being provided, in the vicinity of the said inlet/outlet, with a cover which is designed as a sealing surface. A plate of this type is more particularly a separator plate in a fuel cell stack. A number of channels which extend parallel to one another, for example in the form of a zigzag from one side of the separator plate to the other side of the separator plate, thus covering the maximum possible area, are formed in a separator plate of this type by milling or in some other way. Channels of this type can be used for the anode gas or cathode gas and may be of any conceivable shape, for example may be U-shaped or V-shaped or trapezium-shaped.

During assembly to form an electrochemical cell, a further plate is placed onto a plate of this type and it is necessary to seal the various components of the cell with respect to one another. In particular, it is important to seal the electrochemically active region and the gas-inlet opening which is formed in the plates with respect to one another and with respect to the outside of the cell stack. This seal is produced by fitting an O-ring or the like, for which purpose it is necessary to have zones which are flat with respect to one another and lie around regions to be sealed. If an O-ring or the like is used, without further measures, and an O-ring of this type is laid over the groove or grooves, in the event of deformation this O-ring will be pressed into the grooves and at the location of the grooves it is no longer possible to ensure a complete seal and completely unimpeded flow of gases or the like.

Therefore, it is proposed in the prior art, for example US Patent 5,108,849 to arrange a separate bridge part where the grooves open out into the inlet/outlet. This bridge part is a small metal plate which is placed in a slightly recessed part of the separator plate. As a result, the cross-sectional area of the grooves is not affected or is scarcely affected, and there is sufficient supporting area to function as a sealing surface for, by way of example, an O-ring or the like.

The fitting of such an auxiliary part leads to a sealing problem between the auxiliary part and the separator plate. Moreover, high demands are imposed on such small plates or bridge parts, since they have to be thin. Consequently, they will generally be made from metallic material, which may cause corrosion problems. Moreover, this has the drawback, when producing separator plates on a large scale, that small plates or bridge parts of this type have to be positioned separately.

WO 96/34421 in the name of Stichting Energieonderzoek Centrum Nederland, discloses a layered structure which delimits fluid channels. A number of plates with continuous holes with different patterns are laid on top of one another in order in this way to delimit channels. However, at least three plates are required in order to combine an inlet/outlet for fluid and a seal. As a result, the costs of a structure built up in this way are considerably increased.

The object of the present invention is to avoid this drawback.

In a plate as described above, this object is realised in that said cover comprises a cover which is integral with said plate material. According to the invention, the bridge part is designed integrally with the relevant plate. This eliminates problems with corrosion while, moreover, it is not necessary for the bridge part to be accurately positioned, since it forms a component of the corresponding plate. It is possible for the grooves to extend as drilled holes through the material of the plate. However, this is relatively complicated, and it is preferable for the bridge part to be designed as a recess on the other side thereof. This means that the bridge part has a limited thickness which corresponds, for example, to half the thickness of the plate material. In this case, the recess may be provided with thickened portions which function as support points, so that the forces exerted by the seal do not cause the bridge part to bend or break.

In this way, firstly sufficient strength is imparted for it to function as a sealing surface, and secondly it is ensured that there is sufficient clear cross-sectional area to allow unimpeded flow of the corresponding fluid.

Production can be simplified further if there is a further opening, which extends all the way through the relevant plate, between the bridge part and the end of the groove or grooves.

The plate described above can particularly efficiently be produced on a large scale using, for example, injection-moulding of electrically conductive plastics material. This applies in particular if the plate is used for a fuel cell which operates at a relatively low temperature. Naturally, a suitable plastic has to be selected for the injection-moulding of plates of this type.

The plates can be joined to one another by welding, but it is also possible to use types of adhesive for this purpose and more particularly to use types of adhesive which conduct heat and current.

The invention also relates to an assembly comprising two plates as described above, these plates being attached to one another with the grooves facing away from one another. Cooling channels may be incorporated in the space between the plates.

It will be understood that an assembly of this type can particularly effectively be combined with a membrane electrode assembly (MEA). In this way, the number of components of an electrochemical cell stack is considerably restricted.

The invention will be explained in more detail below with reference to an exemplary embodiment which is illustrated in the drawing, in which:

Fig. 1 shows a plan view of a first plate according to the invention;

Fig. 2 shows a view from below of a second plate according to the invention;

5 Fig. 3 shows a perspective view of detail III from Fig. 2; and

Fig. 4 shows a perspective, partially cut-away view of a plate assembly according to the invention.

In Fig. 1, a first separator plate according to the invention is denoted overall by 1. It may be a plate which consists of a mixture of plastic and graphite and is  
10 produced, for example, by injection-moulding. There are openings at the edge of this separator plate. 4 denotes an inlet opening for anode gas, while 5 denotes the outlet opening for this gas. Openings 6-9 are also present, but are not shown as being connected in further detail. A number of grooves or channels 13 extend between openings 4 and 5. These grooves or channels are of U-shaped design and are open at the top in the plane of  
15 the drawing shown in Fig. 1. 11 denotes a continuous auxiliary opening. 10 denotes a bridge part which comprises thinned material, as can be seen from Fig. 3. It can be seen from this figure that this bridge part 10 extends only over approximately half the thickness of the plate 1. The remaining part creates a recess 14. As a result, gas emanating from the grooves 3 can flow without obstacle to or from opening 5.

20 Fig. 2 shows a further separator plate 2, which is provided with the same openings 4-9. This plate is viewed from the rear side, which means that the U-shaped grooves or channels 12 arranged therein are shown by dashed lines, since they are open towards the underside of the plane of the drawing. Opening 8 is an inlet channel for cathode gas, while opening 9 is an outlet channel. In this plate too, there is a bridge part  
25 10 and an auxiliary opening 11. Recess 14 faces towards the top side.

A separator plate assembly is shown in Fig. 4. In this assembly, the plates 1 and 2 illustrated in Fig. 1 and 2 are arranged against one another, and more particularly are attached to one another by welding, in such a manner that the grooves or channels 3, 12 always lie on the outer side. The active part of the cell, i.e. the electrode assembly,  
30 can be arranged on the grooves 3 or 12, with the result that anode or cathode gas can be brought into active communication with the electrode in question.

It can be seen from Fig. 4 that openings 6 and 7 are connected to a further channel, namely a cooling channel 13, which extends between the plates. The plates shown in this figure can be produced in a simple way by injection-moulding, for  
35 example. Assembly can then take place. It is not necessary to add further components during assembly. After assembly, combination with further membrane electrode assemblies is possible. The seal between the openings 4-8 and membrane electrode assemblies of this nature is not shown but may comprise any seal which is known in the

prior art. The bridge parts ensure that the sealing surface is sufficiently stable, in order to prevent gases from escaping from the separator plate assemblies.

It will be understood that the above inventive idea can be applied to all kinds of plate structures in the prior art in which hitherto separate bridge parts have been used.

- 5 Integration allows the production of connections of grooves or channels to inlet/outlet openings to be considerable simplified. Naturally, various grooves may be present.

Variants which lie within the scope of the appended claims will be immediately obvious to the person skilled in the art on reading the above description.

Claims

1. Plate (1, 2) provided with a fluid channel designed as a groove (3), said plate being suitable for forming part of an electrochemical cell stack, said plate being provided with an inlet (4, 8) and/or outlet (5, 9) adjoining said fluid channel, said inlet/outlet comprising a continuous opening which extends perpendicular to the surface of the said plate, said channel being provided, in the vicinity of the said opening, with a cover which is designed as a sealing surface, characterized in that said cover comprises a cover (10) which is integral with said plate material and delimits a recess (14) in the said plate material.
2. Plate according to Claim 1, wherein the said opening comprises at least two parts, a first part extending through the plane of the plate and a second part which comprises said recess (14) with cover (10), the part of the plate which lies opposite the said cover being provided with grooves (3, 12) opening out into the said recess.
3. Plate according to Claim 2, wherein said opening comprises a third part, adjacent to said recess and remote from said part, said third part comprising an opening extending through said plate and into which said groove opens.
4. Plate according to one of the preceding claims, comprising an injection-moulded part.
5. Assembly (21) comprising two plates (1, 2) according to one of the preceding claims which bear against one another, said grooves (3, 12) being arranged on the sides of the plates which face away from one another.
6. Assembly according to Claim 5, wherein channels (13) for a further medium are arranged between the plates.
7. Assembly according to Claim 5 or 6, wherein the said plates are joined by welding.
8. Assembly according to one of Claims 5-7, wherein the said plates are joined by adhesive bonding.
9. Electrochemical cell stack, comprising membrane electrode assemblies and plate assemblies according to one of Claims 5-8.

1/3

fig-1

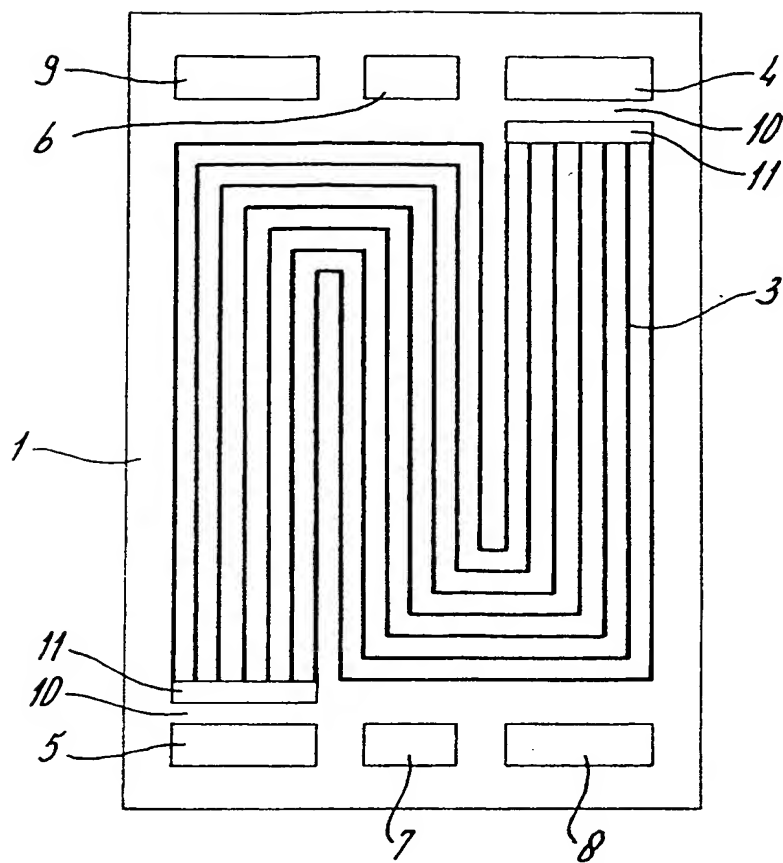
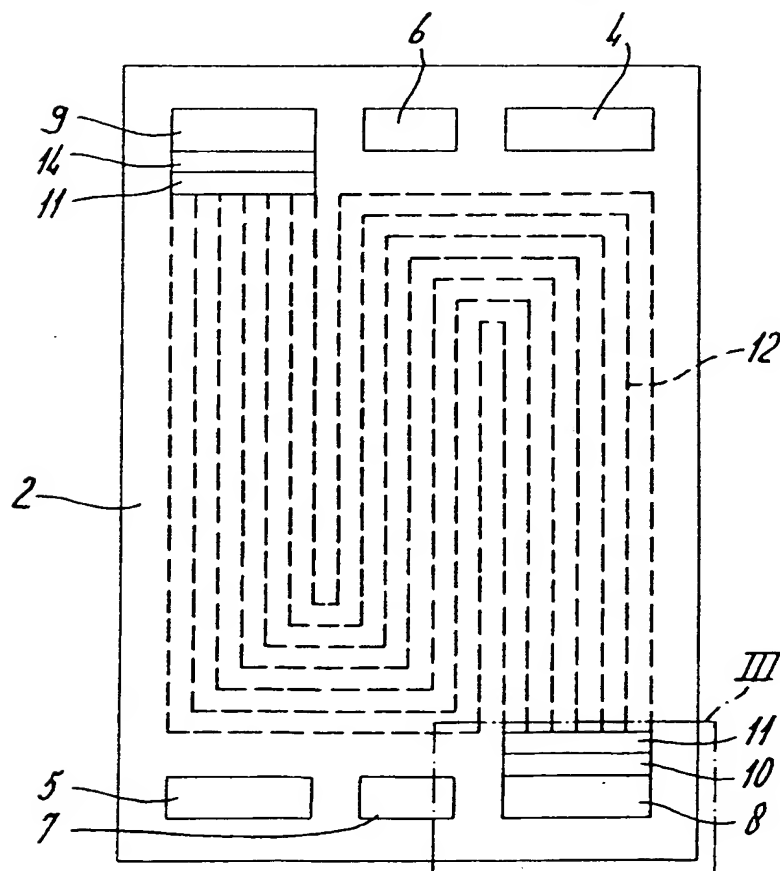
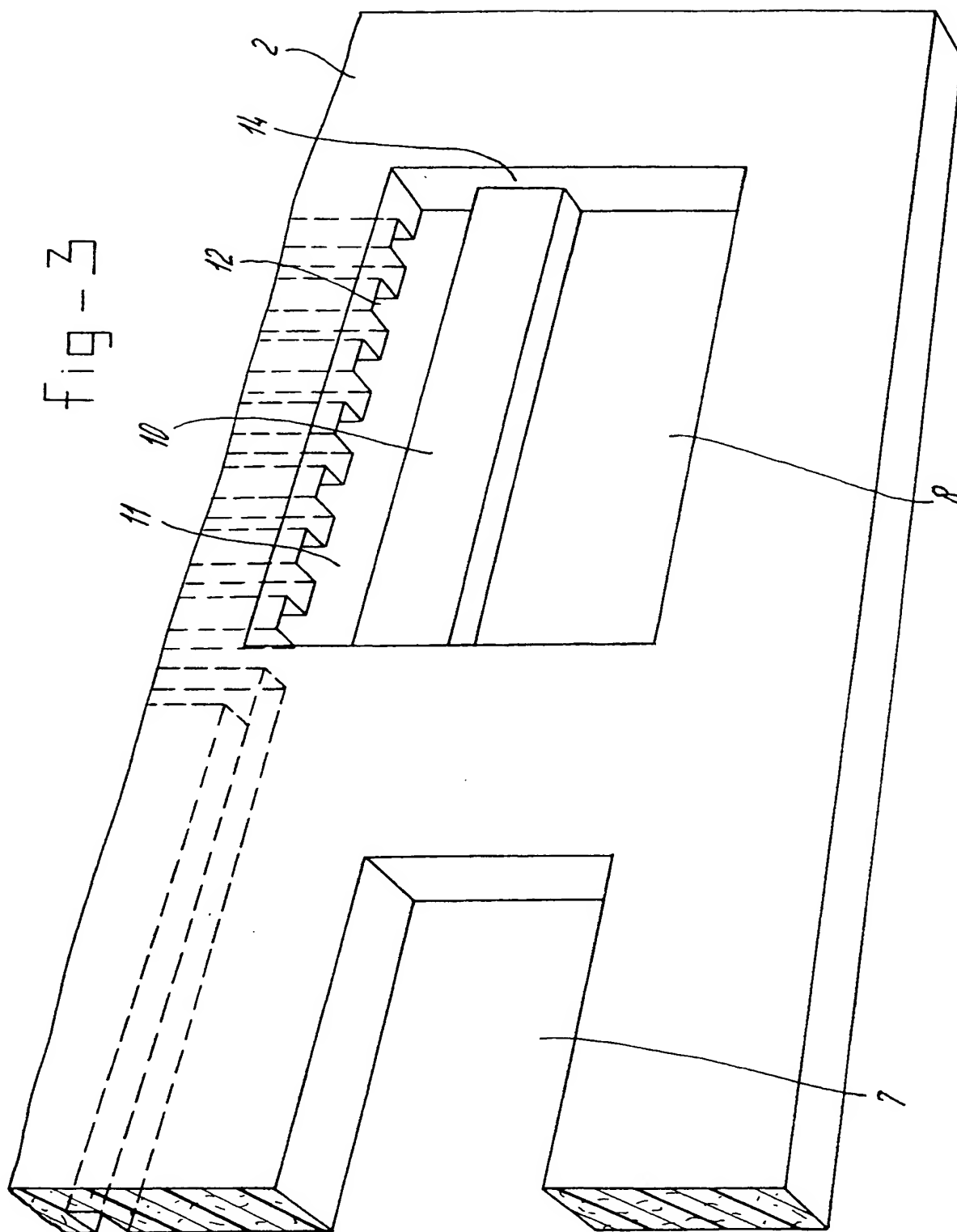


fig-2



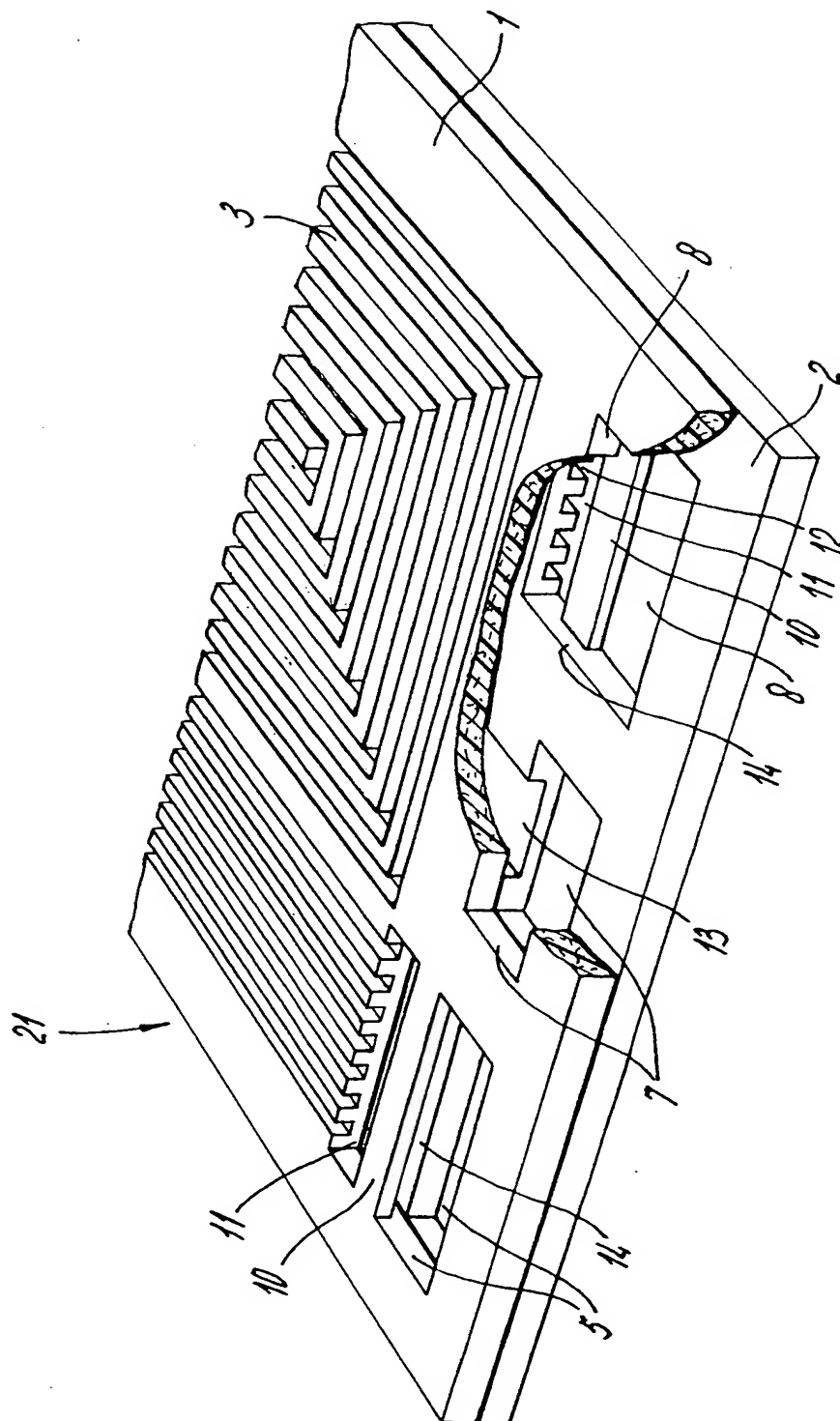
2/3





3/3

fig-4



## INTERNATIONAL SEARCH REPORT

International Application No

PCT/NL 01/00234

A. CLASSIFICATION OF SUBJECT MATTER  
IPC 7 H01M8/02

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H01M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

WPI Data, EPO-Internal, PAJ

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category * | Citation of document, with indication, where appropriate, of the relevant passages   | Relevant to claim No. |
|------------|--|-----------------------|
| A          | WO 96 34421 A (STICHTING ENERGIE ;BOERSMA REINDER JACOBS (NL); KOENE FRANCISCUS G,) 31 October 1996 (1996-10-31) cited in the application page 3, line 31 -page 5, line 11 figures 1-4 | 1-9                   |
| A          | EP 0 774 794 A (DAIMLER BENZ AG, STUTTGART, DE) 21 May 1997 (1997-05-21) page 2, line 23 -page 5, line 34 figure 3   | 1,2                   |
| A          | US 5 108 849 A (EPP DANNY G ET AL, NORTH VANCOUVER, CA) 28 April 1992 (1992-04-28) cited in the application column 4, line 11 -column 6, line 32 figure 4                              | 1-9                   |
|            | ---  |                       |
|            | --- --/--  |                       |

☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

## \* Special categories of cited documents:

\*A\* document defining the general state of the art which is not considered to be of particular relevance

\*E\* earlier document but published on or after the international filing date

\*L\* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

\*O\* document referring to an oral disclosure, use, exhibition or other means

\*P\* document published prior to the international filing date but later than the priority date claimed

\*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

\*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

\*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

\*G\* document member of the same patent family

Date of the actual completion of the international search

27 June 2001

Date of mailing of the international search report

04/07/2001

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Peis, S

## INTERNATIONAL SEARCH REPORT

International Application No

PCT/IL 01/00234

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

| Category * | Citation of document, with indication, where appropriate, of the relevant passages        | Relevant to claim No. |
|------------|---|-----------------------|
| A          | DE 42 37 602 A (SIEMENS AG, MÜNCHEN, DE)<br>11 May 1994 (1994-05-11)<br>figure 1<br>----- | 5,9                   |

## INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/IL 01/00234

| Patent document<br>cited in search report |   | Publication<br>date | Patent family<br>member(s) | Publication<br>date |
|---|---|---------------------|----------------------------|---------------------|
| WO 9634421                                | A | 31-10-1996          | NL 1000218 C               | 28-10-1996          |
|   |   |                     | AU 5409796 A               | 18-11-1996          |
| EP 0774794                                | A | 21-05-1997          | DE 19542475 A              | 22-05-1997          |
|   |   |                     | DE 59605237 D              | 21-06-2000          |
|   |   |                     | US 5928807 A               | 27-07-1999          |
| US 5108849                                | A | 28-04-1992          | US 4988583 A               | 29-01-1991          |
|   |   |                     | AU 633348 B                | 28-01-1993          |
|   |   |                     | AU 6128690 A               | 07-03-1991          |
|   |   |                     | CA 1314306 A               | 09-03-1993          |
|   |   |                     | DE 69013626 D              | 01-12-1994          |
|   |   |                     | DE 69013626 T              | 24-05-1995          |
|   |   |                     | EP 0415733 A               | 06-03-1991          |
|   |   |                     | JP 2711018 B               | 10-02-1998          |
|   |   |                     | JP 3205763 A               | 09-09-1991          |
|   |   |                     | KR 199866 B                | 15-06-1999          |
| DE 4237602                                | A | 11-05-1994          | WO 9411913 A               | 26-05-1994          |
|   |   |                     | EP 0667042 A               | 16-08-1995          |
|   |   |                     | JP 8502851 T               | 26-03-1996          |
|   |   |                     | NO 951780 A                | 05-05-1995          |